

PATENT ABSTRACTS OF JAPAN

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(54) MANUFACTURING METHOD OF FIELD-EMISSION DISPLAY ELEMENT

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a plain-plate display element in which highly minute and sophisticated pixel patterns with a low manufacturing cost can be possible and can improve electron emission effect.

SOLUTION: The manufacturing method of this field-emission display element comprises a stage in which an electro-conductive paste is manufactured, a stage in which the electro-conductive paste is coated on the substrate by using a thick film technique, a stage in which an electrode having the prescribed pattern is formed by removing a part of the electro-conductive paste according to a desired pattern by utilizing a laser-abrasion method, a stage in which surface-electron emission paste is manufactured with a carbonaceous material, a stage in which the manufactured surface-electron emission paste is coated on the whole surface of the substrate having the formed electrode by utilizing the thick film technique, and a stage in which only the surface-electron emission paste is removed according to a desired pattern by utilizing the laser-abrasion method to form an emitter.

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CLAIMS

[Claim(s)]

[Claim 1] The phase which manufactures conductive paste, and the phase which forms said manufactured conductive paste to a substrate using a thick-film technique, The phase which forms the electrode which has a predetermined pattern by using the laser ablation method and removing said a part of conductive paste according to a desired pattern, The phase which manufactures a field electron emission paste by the matter of a carbon sequence, and the phase which forms said manufactured field electron emission paste all over the substrate with which said electrode was formed using the thick-film technique, The manufacture approach of the field emission display device characterized by including the phase which uses the laser ablation method, removes only said field electron emission paste according to a desired pattern, and forms an emitter.

[Claim 2] The phase which manufactures conductive paste, and the phase which forms said manufactured conductive paste to a substrate using a thick-film technique, The phase which manufactures a field electron emission paste by the matter of a carbon sequence, and the phase which forms said field electron emission paste to said formed conductive paste up side using a thick-film technique, The manufacture approach of the

field emission display device characterized by including the phase which uses the laser ablation method, removes some of conductive paste and field electron emission pastes according to a desired pattern, and forms an electrode and an emitter in coincidence.

[Claim 3] Said conductive paste is the manufacture approach of the field emission display device according to claim 1 or 2 characterized by forming membranes all over the 1 side of a substrate by screen printing or slurry method.

[Claim 4] Said field electron emission paste is the manufacture approach of the field emission display device according to claim 1 or 2 characterized by membranes being formed by the front face of said conductive paste with screen printing.

[Claim 5] Said field electron emission paste is the manufacture approach of the field emission display device according to claim 1 or 2 characterized by consisting of matter containing a graphite.

[Claim 6] Said field electron emission paste is the manufacture approach of the field emission display device according to claim 1 or 2 characterized by consisting of matter containing a carbon nanotube.

[Claim 7] The laser used for said laser ablation method is the manufacture approach of a field emission display device given in any 1 term of claims 1-6 characterized by having a 562-1064nm wavelength range.

[Claim 8] The laser used for said laser ablation method is the manufacture approach of a field emission display device given in any 1 term of claims 1-6 characterized by consisting of IR laser.

[Claim 9] Said conductive paste is the manufacture approach of the field emission display device according to claim 1 or 2 characterized by consisting of ITO (Indium Tin Oxide).

[Claim 10] Said conductive paste is the manufacture approach of the field emission display device according to claim 1 or 2 characterized by consisting of a metal.

[Claim 11] Said metal is the manufacture approach of the field emission display device according to claim 10 characterized by consisting of aluminum or chromium.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]

[Field of the Invention] This invention relates to the manufacture approach of the field emission display device in which highly-minimizing of a pixel pattern and improvement in the electron emission effectiveness are possible, though a manufacturing cost is reduced in more detail with respect to the manufacture approach of a field emission display device.

[0002]

[Description of the Prior Art] Generally, a field emission display device (FED;Field Emission Display) is a display device which the electron which was made to emit an electron and was emitted from the emitter of a negative electrode using the quantum-mechanical tunneling effectiveness is made to collide with the fluorescent substance of a positive electrode, and embodies a predetermined image. Here, a negative electrode means the electrode which approves driver voltage to an emitter and said emitter, and a positive electrode means the electrode which approves driver voltage to a fluorescent substance and said fluorescent substance. As an emitter to which an electron is made to emit, there are an emitter of the Spindt (Spindt) type with which the tip is sharp, and an emitter even field type.

[0003] Drawing 5 shows the field emission display device of the diode structure of having a field type emitter. A field emission display device contains the 2nd electrode 18 arranged in the Rhine configuration at the whole surface of the 2nd substrate 14 so that it may cross at right angles to the 1st electrode 16 arranged in the Rhine configuration at the whole surface of the 1st substrate 12 and the 2nd substrate 14 by which set fixed spacing and opposite arrangement is carried out as illustrated, and the 1st substrate 12, and the 1st electrode 16.

[0004] And many field type emitters 20 which consist of matter for electron emission are located in the front face of the 1st electrode 16. A negative electrode is constituted by the 1st electrode 16 and the emitter 20. The fluorescent screen 22 of green [each], blue, and red is located in the whole surface of an emitter 20 and the 2nd electrode 18 which counters. A positive electrode is constituted by the 2nd electrode 18 and the fluorescent screen 22.

[0005] Here, the space where the 1st electrode 16 and the 2nd electrode 18 cross comes to constitute one pixel.

[0006] Thereby, if an electrical-potential-difference pattern predetermined with the 1st electrode 16 and the 2nd electrode 18 is approved, electric field will be formed of the difference of the electrical potential difference approved by the 1st electrode 16 which constitutes one pixel, and the 2nd electrode 18, and it will come to

emit an electron in the direction of an arrow head from an emitter 20 according to it. By colliding with a fluorescent screen 22 and making a fluorescent screen 22 emit light, the emitted electron comes to embody a predetermined image.

[0007] Thus, in the electroluminescence display device constituted, as field emissive material, the matter of carbon sequences, such as diamond-like carbon (DLC;Diamond Like Carbon), carbon fiber, and a carbon nanotube (CNT:Carbon Nanotube), is mainly used, and the transparent electrode by the ITO (Indium Tin Oxide) film is used as the 1st electrode.

[0008] and as an approach of forming a field type emitter in the 1st substrate (a) Membrane-formation-ize a field type emitter using a thin film facility, and a wet etching technique is used for this.

Electroluminescence array () [FEA:Field Emission] Constitute Array, or manufacture the matter of (b) carbon sequence to a paste (paste), and thick-film techniques, such as a slurry (slurry) and screen printing (screenprinting), are used for this. There is the approach of applying to the 1st electrode bottom and constituting in an electroluminescence array.

[0009]

[Problem(s) to be Solved by the Invention] However, according to the former (a) approach, formation of a pixel pattern is easy, highly-minute-izing of a pixel pattern is possible, but there is a trouble that a manufacturing cost is high and a process is complicated.

[0010] And although a manufacturing cost is low and a process is easy, since the magnitude of the distance between pixels in the mesh of the mask used for a thick-film technique and the pixel itself has a limit according to the latter (b) approach, there is a trouble that highly-minute-izing of less than 100 microns or formation of a detailed pattern is very difficult.

[0011] Though a manufacturing cost is low, highly-minute-izing of a pixel pattern is possible for the place which this invention was made in view of such a trouble, and is made into the purpose, and it is to offer the manufacture approach of the monotonous display device which the electron emission effectiveness can improve.

[0012]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, this invention The phase according to claim 1 which manufactures conductive paste like, The phase which forms said manufactured conductive paste to a substrate using a thick-film technique, The phase which forms the electrode which has a predetermined

pattern by using the laser ablation method and removing said a part of conductive paste according to a desired pattern, The phase which manufactures a field electron emission paste by the matter of a carbon sequence, and the phase which forms said manufactured field electron emission paste all over the substrate with which said electrode was formed using the thick-film technique, The laser ablation method is used and the manufacture approach of the field emission display device characterized by including the phase which removes only said field electron emission paste according to a desired pattern, and forms an emitter is offered.

[0013] According to another viewpoint of this invention, the phase according to claim 2 which manufactures conductive paste like, The phase which forms said manufactured conductive paste to a substrate using a thick-film technique, The phase which manufactures a field electron emission paste by the matter of a carbon sequence, and the phase which forms said field electron emission paste to said formed conductive paste up side using a thick-film technique, The laser ablation method is used and the manufacture approach of the field emission display device characterized by including the phase which removes some of conductive paste and field electron emission pastes according to a desired pattern, and forms an electrode and an emitter in coincidence is offered. Thus, when forming the electric conduction film and the field electron emission film, a thick-film technique is used, and if an electrode and an emitter are formed by forming a pattern for this electric conduction film and the field electron emission film using the laser ablation method, though a manufacturing cost is reduced, highly minute-ization of a pixel pattern will be attained.

[0014] In that case, a thing [that said conductive paste is formed all over the 1 side of a substrate by screen printing or slurry method] according to claim 3 is [like] desirable. Screen printing is easy to furnish and the platemaking process which forms a pattern is comparatively easy for it. Moreover, said field electron emission paste may form membranes on the front face of said conductive paste with screen printing like the publication to claim 4. And as for said field electron emission paste, it is desirable to constitute so that it may consist of matter containing a graphite according to claim 5 like, and since the absorption coefficient of a graphite of the energy to a laser beam is high compared with other matter of oxide (oxide) or a silicon sequence, in case it uses the laser ablation method, it can form it efficiently. Moreover, it can be desirable to constitute so that it may consist of matter containing a carbon nanotube according to claim 6 like,

when this irradiates a laser beam at an etching part and an emitter is formed, a carbon nanotube can be exposed to the front face of the emitter of an etching part, the carbon nanotube which carries out an electron emission operation can increase, and said field electron emission paste can make the field electron emission effectiveness maximum-ize.

[0015] When using the matter containing a carbon nanotube, the thing [having a 562-1064nm wavelength range] according to claim 7 of the laser used for the laser ablation method is [like] desirable. Or a thing [using IR laser especially with the high absorption coefficient of energy among carbon sequence matter] according to claim 8 is [like] desirable. Moreover, a thing [that said conductive paste consists of hyperviscous ITO (Indium Tin Oxide) like so that printing may be suited] according to claim 9 is desirable. Or like the publication to claim 10, it is made for said conductive paste to consist of a metal, and said metal is good for claim 11 also as aluminum or chromium like a publication.

[0016]

[Embodiment of the Invention] Hereafter, with reference to the attached drawing, the manufacture approach of the field emission display device by the desirable example of this invention is explained more to a detail. Drawing 1 is the flow chart of the process which showed the target the manufacture approach of the field emission display device by one example of this invention one by one. Conductive paste is manufactured first (S10). Next, the manufactured conductive paste is formed to a substrate using a thick-film technique (S11). Screen printing, slurry method, etc. can be used for a thick-film technique. And the electrode which has a predetermined pattern is formed by removing said a part of conductive paste according to a desired pattern (S12). Next, a field electron emission paste is manufactured (S13). All over the substrate with which said electrode was formed, said field electron emission paste is formed using a thick-film technique (S14). The laser ablation method is used, only said field electron emission paste is removed according to a desired pattern, and an emitter is formed (S15).

[0017] This is explained to a detail with reference to drawing 2. As for conductive paste, it is desirable to consist of metallic materials, such as hyperviscous ITO (Indium Tin Oxide), or aluminum or Cr, so that printing may be suited.

[0018] When conductive paste consists of ITO especially, as for an ITO paste, it is desirable that the formed element more than a fixed ratio is included. At this time, viscosity is the range which is 10,000-

100,000cps, and, as for the conductive paste which suited printing, it is desirable that the formed element in a paste exists to 10 - 80% of the weight.

[0019] Thus, the electric conduction film is formed by forming the manufactured conductive paste with screen printing on the whole surface of a substrate by one approach in thick-film techniques (screen printing or slurry method), and this example.

[0020] Screen printing is the approach of extruding and printing conductive paste to a printing hand-ed (substrate) through the mesh of a screen mesh using a squeegee or a platen. This is easy to furnish, and since the platemaking process which forms a pattern is comparatively easy, it is widely used for printing of various fields.

[0021] Screen-stencil of conductive paste makes a substrate and a screen mesh fix to a screen-stencil machine, and consists of a process which prints conductive paste to a substrate using a squeegee.

[0022] Through the aforementioned approach, as illustrated to drawing 2 A, the electric conduction film 4 is printed all over the 1 side of a substrate 2. Then, an electrode 6 is completed using the laser ablation method. This is shown in drawing 2 B.

[0023] The laser ablation method is one of the desiccation type etching techniques which enabled it to etch a desired part, the matter of the minute field where the energy of a laser beam was absorbed by the quality of an etching object, and absorbed momentarily big energy being plasma-sized if a laser beam is irradiated, after doubling a focus with a desired etching part. The field of etching is determined by the diameter of a laser beam.

[0024] And the above electrode formation activities lay a substrate on the processing table which can transport a substrate, they may be carried out, making a substrate transport in the biaxial direction (the direction of front and rear, right and left on a processing table), and they may be carried out, making a laser ablation unit transport, where a substrate is fixed.

[0025] Thus, a field electron emission paste is manufactured by carbon sequence matter, such as oxide (oxide) after forming an electrode 6, a graphite (graphite) with the high absorption coefficient of energy [as opposed to a laser beam compared with other matter of a silicon sequence], or a carbon nanotube, and this is made to fix, after forming the manufactured field electron emission paste with screen printing all over the 1 side of the substrate with which the electrode was formed and forming the field electron emission film 8. This is shown in drawing 2 C.

[0026] Here, when setting the original source matter of a field electron

to 1, as for the presentation ratio of said field electron emission paste, it is desirable to consist of the glass powder (glass powder) of 0.5-0.8, silver (silver) of 0.5-0.8, and a binder of 2-20.

[0027] Thus, after forming the field electron emission film 8, by irradiating a laser beam using the above-mentioned laser ablation method, only the field electron emission paste of a desired etching part is removed, and an emitter 10 is formed. This is shown in drawing 2 D.

[0028] Especially as field emissive material, it is desirable at the time of formation of such an emitter that a carbon nanotube (carbon nanotube) is included. When irradiating a laser beam at an etching part and forming an emitter 10, the reason is because a carbon nanotube (CNT) is exposed to the front face of the emitter 10 of said etching part, the carbon nanotube which carries out an electron emission operation by this increases and the field electron emission effectiveness is maximum-sized, as shown in the enlarged drawing of drawing 2 D.

[0029] And a laser beam especially uses infrared (IR:infrared) laser especially with the high absorption coefficient of energy among carbon sequence matter, and uses the laser which has the wavelength of about 562-1064nm for the matter containing a carbon nanotube.

[0030] Thus, if a pattern is formed using a laser beam, a pattern can be formed to a less than 10-micron patterning field, and formation of a detailed pattern will be attained. Moreover, the field electron emission effectiveness can be raised with the carbon nanotube exposed to the emitter front face of the part etched by the laser beam.

[0031] Drawing 3 is the flow chart of the process which showed the target the manufacture approach of the field emission display device by other examples of this invention one by one. Conductive paste is manufactured first (S20). The manufactured conductive paste is formed to a substrate using screen printing (S21). Next, a field electron emission paste is manufactured (S22). To the formed conductive paste up side, said field electron emission paste is formed using screen printing (S23). The laser ablation method is used, some of conductive paste and field electron emission pastes are removed according to a desired pattern, and an electrode and an emitter are formed in coincidence (S24).

[0032] If this is explained with reference to drawing 4, conductive paste will consist of metals, such as hyperviscous ITO (Indium Tin Oxide), or aluminum or Cr, like the example of drawing 1, and will form the electric conduction film by forming the conductive paste manufactured in this way with screen printing on the whole surface of a substrate.

[0033] Through the aforementioned approach, as shown in drawing 4 A, the

electric conduction film 4 is printed all over the 1 side of a substrate 2. Then, a field electron emission paste is manufactured by the above-mentioned carbon sequence matter (matter containing especially a carbon nanotube), the field electron emission paste which manufactured is formed with screen printing on the top face of the electric conduction film 4, and the field electron emission film 8 is formed. This is shown in drawing 4 B.

[0034] Thus, after forming the field electron emission film 8, said laser ablation method is used and an electrode 6 and an emitter 10 are formed in coincidence by irradiating the etching part of a request of a laser beam and removing conductive paste and a field electron emission paste to coincidence. This is shown in drawing 4 C.

[0035] At this time, a laser beam uses the laser which has infrared laser (IR Laser) or the wavelength of about 562-1064nm. It is possible by adjusting the energy of a laser beam to remove conductive paste and a field electron emission paste to coincidence.

[0036] And although not illustrated, as shown in drawing 2 D also in this case, a carbon nanotube is exposed to the emitter front face of an etching part.

[0037] Thus, according to this example which forms an electrode and an emitter in coincidence, a process can be simplified compared with the example of drawing 1 and drawing 2.

[0038] Although **** explained the desirable example of this invention, this invention is not limited to this, in a claim, a detailed description, and the attached range of a drawing, many things are transformed, it can be carried out, and that of this also belonging to the range of this invention is natural.

[0039]

[Effect of the Invention] Thus, according to the manufacture approach of the field emission display device by this invention, since a thick-film technique with a low manufacturing cost and the laser ablation method in which detailed pattern formation is possible are used complexly, though a manufacturing cost is reduced, highly minute-ization of a pattern is attained.

[0040] Therefore, according to the approach of this invention, production of a field emission display device applicable to the product of highly-minute-izing like a desktop monitor is attained.

[0041] Moreover, if field emissive material contains a carbon nanotube, since a carbon nanotube will be exposed to the front face of the emitter of an etching part with the energy of a laser beam, the field electron emission effectiveness can be maximum-ized.

[0042] In addition, according to the approach of this invention, Rhine patterning can be carried out two-dimensional, patterning of products various to coincidence is possible at one process, and at least the easy activity which replaces a patterning picture can form various patterns at the time of a design change or product modification, without changing a circumference facility of a mask etc.

[0043] Moreover, since an electrode can be formed at the process simplified more, the time amount which carries out necessary to a whole routing counter and a whole process can be shortened, and the productive efficiency of a field emission display device can be effectively raised by this.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the flow chart of the process which showed the target the manufacture approach of the field emission display device by one example of this invention one by one.

[Drawing 2] It is the drawing in which the negative electrode of the field emission display device manufactured by the approach of drawing 1 is shown in graph.

[Drawing 3] It is the flow chart of the process which showed the target the manufacture approach of the field emission display device by other examples of this invention one by one.

[Drawing 4] It is the drawing in which the negative electrode of the field emission display device manufactured by the approach of drawing 3 is shown in graph.

[Drawing 5] It is the sectional view of the field emission display device which has an emitter common field type.

[Description of Notations]

2 Substrate

4 Electric Conduction Film

6 Electrode

8 Field Electron Emission Film

10 20 Emitter

12 1st Substrate

14 2nd Substrate

16 1st Electrode

18 2nd Electrode
22 Fluorescent Screen
